Developing an Integrated water resources management and rainwater harvesting system in South Africa.

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Abstract
In the last two decades, interest in rainwater harvesting (RWH) has grown, especially in arid and semi-arid areas. It is advocated that RWH has the potential of alleviating spatial and temporal water scarcity for domestic, crop and livestock production, environmental protection and supporting overall water resources management. South Africa remains a water scarce country where the potential of RWH has not yet been fully explored.
At the plot scale, studies highlight the socio-economic benefits of RWH but very little has been done to evaluate its impacts on the hydrological cycle and as well as possible effects that could result from an upscaling of RWH to catchment level. The National Water Act (Act 36 of 1998) and the National Water Services Act (Act 108 of 1997) are silent on this alternative option for reconciling demand and supply.
The paper presents preliminary work on the development of a decision support system for the integration of RWH in the development and management of water resources in South Africa. It aims at addressing the above issues from an integrated water resources management (IWRM) perspective.

Keywords: *RWH, upscaling, decision support system, IWRM, South Africa*

1. Introduction

The average rainfall of South Africa is just over half of the world average. The rainfall is strongly seasonal and highly irregular in occurrence. It is also unevenly distributed spatially. As a consequence of this and the uneven topography, more than 60% of the river flow arises from only 20% of the area. It is estimated that 9% of the country's precipitation finds its way as runoff into rivers and streams (ICID, 2004). South Africa has a population of about 46.9 millions (Statistics South Africa, 2005). In 2001, 11.2 million (25per cent) of the population did not have access to adequate water services and 18.1 millions (41per cent) did not have adequate sanitation services (Eberhard, 2003). In 2004, approximately 14 millions South Africans, or a third of the total population, were vulnerable to food shortages. The reason for this is closely linked to lack of suitable infrastructure, water and land resources for viable agriculture in deep rural areas, despite the fact that South Africa is a net food exporter (FAO, 2005).
To balance supply and demand, the traditional response to pressure on water resources has mainly been supply oriented. About 320 major dams have been built over the past decades, each with full supply capacity exceeding 1 million cubic metres (DWAF, 2004a). South Africa is fast reaching the limits of what can be achieved if the conventional supply oriented approach is maintained to meet the growing demand for water. The country's need will not be met sustainably unless managerial and technological innovations are brought to bear on all facets of water management. Current strategies include, among others, better use of the existing resources and investigation of less conventional sources. Water demand management to induce behaviour change among users, effluent reuse, importation of water from well watered countries, desalinisation of sea water as well as RWH (See figure 1) to further augment water supplies are options already being pursued or at least investigated (IFAP, 2005). About 90 per cent of the South African arable land is rainfed (IPTRID, 2000) and irrigation account for about 62 per cent (see figure 2) of the total water requirement in the country (DWAF, 2004a).

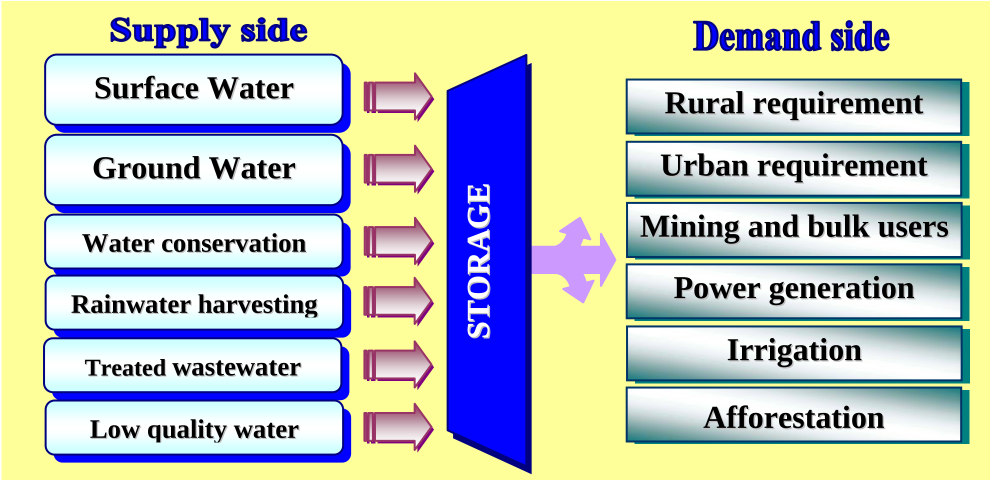

Figure 1. Supply versus demand in South Africa (Adapted from Prinz, 1999)

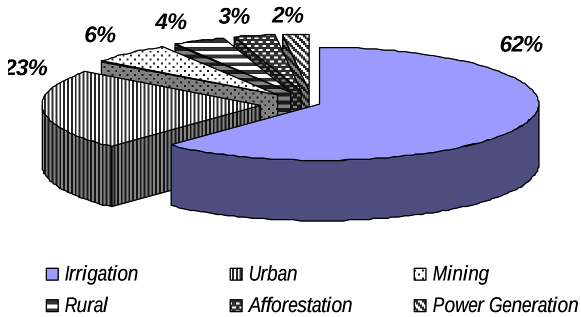

Figure .2 South African water requirements by sector

To combat hunger and improve food security RWH could be another viable water source to pursue. It could also contribute to improve water access for drinking and for other basic human needs. There is therefore a need to investigate the potential that RWH holds for South Africa. The paper presents preliminary work of a three-year Water Research Commission funded project. The study attempts to develop a Decision Support system that will guide practitioners and decision makers on the opportunities offered by RWH systems to South Africa. It also includes a socio-economic component that will bring about the development of appropriate policy and legislative tools for the wide scale use of RWH in South Africa. The three-year study is in its inception phase and the work presented outlines results of a literature survey, and describes the methodology that will be followed in the project. One hallmark of the study is its collaborative nature involving the private sector, Non Governmental Organisation (NGO), applied research and academic institutions from within and outside South Africa.

2. RWH in South Africa

RWH in the broad sense describes the small-scale concentration, collection, storage, and use of rainwater runoff for both domestic and agricultural purposes (Gould, 1999). It is made of the following components:

- A catchment or collection area: where water is harvested. It can be a rooftop, a path, a road, a rock, a marginal land, etc.
- A storage facility and/or conveyance system: where the water harvested in the catchment area is stored. The storage can either be a reservoir (surface and subsurface), a cistern, the soil profile, etc.
- A targeted area: where the harvested water is used. The targeted area can be human beings, crops, plants, animals, enterprise, etc.

RWH systems can be categorised depending on the type of catchment surface and by implication the scale of activity (Smet and Moriarty, 2001).

When categorised according to catchment area, these types of RWH systems emerge:

- Domestic or rooftop RWH in which water is collected from roof tops, courtyards and similar compacted or treated surfaces and used for domestic purpose or garden crops.
- Micro-catchment RWH also referred as in-field RWH (Botha et al, 2003). The catchment and target areas are directly adjacent to one another. These systems use part of the catchment as target area (arable land).
- Macro-catchment RWH also reffered as ex-field RWH (Botha et al, 2003). In this system, there is appreciable distance between the catchment area and the target area.

It is worth pointing out that RWH is one of the oldest means of collecting runoff for domestic purposes (Smet and Moriarty, 2001). During different periods of man's history, the forms and modes of collection and conveyance of water have varied, depending largely on the technology prevailing at the time.

It is difficult to establish where RWH originated because of the various techniques that were independently invented in different regions of the world. It is also quite a challenge to trace the history of RWH in South Africa. Three monumental historical dispensations appear to have disrupted this indigenous agricultural practice: the Mfecane, the Colonial era and Apartheid (Auerbach, 1997). The Mfecane is an African expression that is used to express chaos and disturbances. It probably connotes the "crushing", adventures from the events leading to the rise to power of chief Shaka. Many tribes migrated to the South, West, North and Northwest, to escape the Zulu invasion (Nationmaster.com, 2005). The colonial era further destroyed what remained of black farming systems while Apartheid consolidated the harm inflicted by the colonial era. However, some traditional farming systems survived these dispensations (Auerbach, 1997).

Many South African commercial farmers visited Australia to learn about RWH systems. The system is often used in pasture production, and uses contour furrows to link dams at keypoints where the slope of the land begins to increase. With advances in technology, dams of considerable height were constructed while water was conveyed along contour furrows and applied on fields. To increase water infiltration and slow down runoff, the system is combined with chisel ploughing on the contour (Auerbach, 1997).

Currently, rooftop RWH is the most wide spread practice in the nine provinces of South Africa. The lack of a national umbrella body that coordinates RWH makes documentation of the practice difficult. However some existing projects have been identified.

In the Limpopo province, the Association of Water And Rural Development (AWARD) addressed the water crisis in Mahashe secondary school by promoting the use of RWH. Learners no longer have to walk across a busy road to fetch water, and in addition the level of sanitation and school attendance have improved (Award, 2003).

To provide water to poor community living in shacks, the eThekwini municipality built $5m^3$ ferrocement tanks in 500 homes in Inanda, Ntuzuma, KwaMashu. First results indicate an improvement of the quality of life of the selected homes. Harvested water is used for gardening, washing and even drinking after proper treatment. The municipality is currently planning to build additional 500 tanks (Naidoo, 2005).

Domestic RWH has proven in rural areas to:

- ease availability and accessibility of water and hence cut down on the time spent to fetch water;
- help vulnerable groups such as elderly people, orphan and HIV infected;
- provide water for small-scale productive activities such as brick making, garden watering, etc;
- have a positive impact on schools.

In urban areas, it is yet to be demonstrated that RWH can:

- delay the construction of wastewater treatment plants by reducing storm water;
- provide a buffer against the effects of droughts and growth in water demand due to population growth.

RWH in the valley of thousand hills was pioneered 40 years ago by Robert Mazibuko who developed a system that replicates the function of wetlands (Auerbach, 1997). Using the technique, farmers of the Nkululeko community garden in the Umgeni River Catchment now cultivate on steep slopes.

Since the 90's the Agricultural Research Council-Institute for Soil, Climate and Water (ARC-ISCW) and the University of the Free State have developed and promoted in-field RWH techniques for small farmers in the Thaba Nchu area in the Free State with the objective of harnessing rainwater for crop production (Hensley *et al*., 2000). Latest survey indicates that about 1033 households are currently using the technique in 42 villages.

Results of the study indicate that in-field RWH:

- increases crop production, making more food available;
- reduces risks of crop failure;
- considerably reduces runoff, resulting in minimal soil losses;
- can provide a family of five with daily caloric requirement of 2500 kilocalories when applied on 3-5 ha;
- increases precipitation-use efficiency.

3. Current legal status of RWH in South Africa

In the line with the advent of a new democracy, the South African government undertook a comprehensive reform of the water sector during the last decade. The National Water Policy of 1997 outlines the direction to be given to the development of water law and water management system in South Africa. The National Water Act (NWA) and the National Water Services Act (WSA) provide the legislative framework for the management and use of water. The objectives of the Acts are, among other things, to meet the basic human needs of present and future generations, to promote equitable access to water, and to redress the results of past racial and gender discrimination (DWAF, 2004a).

The National Water Act (Act No. 36 of 1998) is the principal legal instrument relating to water resources management in South Africa (DWAF, 2004a). The Act deals with the management of water as a national resource, and hence provides for the establishment of institutions for integrated water resource management (James, 2003). The National Water Services Act (Act No. 108 of 1997) provides a regulatory framework for the provision of water supply and sanitation services to which people are entitled. The National Water Resources Strategy (DWAF, 2004a) provides the framework within which water resources have to be developed and managed throughout the country.

Section 3 of Chapter 1 of the Water Services Act states:
(1) *Everyone has a right of access to basic water supply and basic sanitation.*
(2) *Every water services institution must take reasonable measures to realise these rights.*
(3) *Every water services authority must, in its water services development plan, provide for measures to realise these rights.*
And Section 6 states:
(1)*… no person may use water services from a source other than a water services provider nominated by the water services authority having jurisdiction in the area in question, without the approval of that water services authority.*
Based on section 3, rainwater can be harvested to provide water for basic needs. However, strict interpretation of section 6(1) requires users of rooftop RWH systems in urban and peri-urban areas to obtain approval from their service provider.

Section 4 of Chapter 1 of the National Water Act (NWA) recognises the right to use water for purposes such as reasonable domestic use, domestic gardening, and animal watering. Part 3 of Chapter 3 of the NWA specifies part of the water resources called "reserve" consisting of two parts: the basic human needs reserve and the ecological reserve. The basic human need reserve provides for the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene. The ecological reserve relates to the water required for proper functioning of aquatic ecosystems. The Reserve refers to both the quantity and quality of the water resource. Populations not connected to the reticulation system (rural and peri-urban areas) are entitled to the reserve. Not all households are within 200 m of a source of water (a communal tap or a borehole). There is therefore room to argue that rooftop and underground tanks RWH are possible means to provide water for the Reserve for the basic human needs.
Furthermore in Chapter 4, Part 1, section 22 (1), permissible water uses which do not require a license are among others (Schedule 1):
(a) take water for reasonable domestic use in that person's household, directly from any water resource to which that person has lawful access;
(b) take water for use on land owned or occupied by that person, for:
(i) reasonable domestic use;
(ii) small gardening not for commercial purposes; and
(iii) the watering of animals (excluding feedlots) which graze on that land within the grazing capacity of that land, from any water resource which is situated on or forms a boundary of that land, if the use is not excessive in relation to the capacity of the water resource and the needs of other users;
(c) store and use run-off water from a roof;
Rooftop RWH is therefore explicitly recognised as a permissible water use for which no license is required. However, the Act regulates in section 26 (f) any water work.
…the Minister may make regulations ... requiring qualifications for and registration of persons authorised to design, construct, install, operate and maintain any waterworks, in order to protect the public and to safeguard human life and property.
When considering In and ex-field RWH systems the Act states in Chapter 4, Part 4, Section 36 (2):
The Minister may, by notice in the Gazette, in relation to a particular area specified in that notice, declare any activity (including the cultivation of any particular crop or other vegetation) to be a stream flow reduction activity if that activity is likely to reduce the availability of water in a watercourse to the Reserve, to meet international obligations, or to other water users significantly.
Stream flow reduction activities are defined in the Act as land-based activities which reduce stream flow. Whether or not an activity is declared to be a stream flow reduction activity depends on various factors, such as the extent of stream flow reduction, its duration, and its impact on any relevant water resource and on other water use. Although further studies are needed to establish that RWH is a stream flow reduction activity, it nonetheless has the potential of diverting considerable amount of surface runoff, depending of the scale, from the water course. Furthermore, some RWH systems require works that bear semblance to water works since no definition of waterworks is given in the Act.
The suggested potential of RWH to redress racial and gender discrimination and to achieve food security puts it in a position to receive license. The NWA states in section 27 (1) (a) to (d):
(1) In issuing a general authorisation or licence a responsible authority must take into account all relevant factors, including
(a) existing lawful water uses;
(b) the need to redress the results of past racial and gender discrimination;
(c) efficient and beneficial use of water in the public interest;
(d) the socio-economic impact -
(i) of the water use or uses if authorised; or
(ii) of the failure to authorise the water use or uses;

RWH could furthermore be authorised under general authorisation for a certain period as stated by Section 39 of Chapter 4 of the NWA
39. (1) A responsible authority may, subject to Schedule 1, by notice in the Gazette -
(a) generally;
(b) in relation to a specific water resource; or
(c) within an area specified in the notice, authorise all or any category of persons to use water, subject to any regulation made under section 26 and any conditions imposed under section 29.
(2) The notice must state the geographical area in respect of which the general authorisation will apply, and the date upon which the general authorisation will come into force, and may state the date on which the general authorisation will lapse.
(3) A water use may be authorised under subsection (1) on condition that the user obtains any permission or authority required by any other specified law.

In the National Water Resources Strategy (NWRS), the South African Department of Water Affairs and Forestry commit itself to ensure that water management strategies contribute to poverty eradication by prioritising water for productive livelihood. It places emphasises on the needs of predominantly rural population who require water for small-scale activities. It is estimated that availability of 50 to 100 litres of water per household per day in rural areas has the potential to significantly enhance livelihood. To achieve this goal, the NWRS explores ways of avoiding unnecessary administrative burdens on water users and considers new water supply alternatives such as RWH.

RWH is explicitly cited in the NWRS Box 3.2.1. …*The requirements for water need not necessarily be met via piped supplies or using water abstracted from rivers.* ***RWH*** *from roofs or other hardened surfaces, using tanks, small check dams or catchpits can supplement more conventional sources of supply, and more use can be made of groundwater. Soil moisture can be retained on cultivated land and infiltration can be increased by contouring or constructing other* ***micro water retaining structures****, which have limited effects on water resources or downstream users…*(DWAF, 2004a). Although RWH is seen as a water supply option, the NWRS suggests that its effects on water resources or downstream users be limited. A knowledge gap does exist in quantifying the downstream effects of RWH.

As part of effort by the South African government to achieve one of the UN Millennium Development Goals (MDGs) of reducing by half the number of food insecure households, financial assistance is being provided to resource-poor irrigation farmers to about 1000 rainwater tanks per annum (DWAF, 2004b). The grant will be paid to water users associations or other approved legal entities for the capital cost of storage tanks for rain-water and related rain-water harvesting works.

4. Integrated Water Resources Management and RWH

4.1 RWH and the four Dublin principles

Integrated water resources management (IWRM) is defined as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP TAC Background papers, 2000). IWRM involves the coordinated planning of land, water and other environmental resources for their equitable, efficient, and sustainable use (Prinz, 1999). IWRM is based on four following principles known as the Rio-Dublin principles.

Box 1 Dublin Principles

- Freshwater is a finite and vulnerable resource essential to sustain life, development and environment.
- Water development should be based on a participatory approach, involving users, planners and policy makers at all levels.
- Women play a central part in the provision, management, and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognised as an economic good.

a) First Principle: Water as a finite and vulnerable resource essential to sustain life, development and the environment

Management of water resources demands a holistic approach. While RWH sustains life and development by providing water for domestic and productive uses, its implementation should consider both the social-economic benefits of the users and the hydro-ecological impacts on the hydrological cycle. Households can realise substantial economic benefits with use of harvested water for livestock production, gardening, brick making and increased rainfed crop yield through bridging of dry spells. Crop yield increase means higher water intake and therefore modification of water balance at plot level with consequences at basin level. In-field RWH systems hold a substantial part of the induced runoff. Ex-field RWH systems use reservoirs to store harvested water, thereby enhancing evaporation and infiltration. This raises the question: Does RWH reduce surface flow and increase base flow with the overall cumulative increase of the catchment yield? A case in point is Arvari River in India which was ephemeral but has become perennial due to RWH activities. Is this generally the case or an isolated one? Fields results also from in-field RWH systems indicate that they reduce erosion (Prinz, 1996; Botha et al, 2003) but on the other hand, ex-field RWH can increase erosion when the catchment area is kept free of vegetation (Prinz, 1996). Futhermore, when RWH becomes wide spread, the issue of ownership of the runoff arises.

Since the first principle advocates a holistic approach in the management of water, there is a need to investigate the positive and adverse effects of RWH on communities, the hydrological cycle and the environment. It also has to be recognised that the actual amount of water in the hydrological cycle is not increased or reduced through RWH practices since water is a finite resource, but that its vulnerability can be affected by the practice.

b) Second Principle: The need for a participatory approach

RWH projects are mostly promoted by Non Governmental Organisations around the world. In most countries decision makers do not recognise RWH as a water supply option. Successful use and adoption of RWH have been observed when communities were involved at each phase, from planning to implementation. RWH often requires little maintenance from the user. Training is crucial for uptake of the technology, while participatory involvement of the community goes a long way in adopting the most appropriate technology. However, the needs and priorities of the community should be incorporated at the

early stage of the planning. Because of the bottom up approach, RWH projects are scattered and therefore lack coordination. Mechanisms for conflict prevention and resolution can only be effective when recognised at decision makers' level. A legal basis for the use of RWH will only reinforce its sustainability.

c) Third Principle: The important role of women

Women often walk long distances to fetch water in most rural areas of Africa. The education of girls is often low because of the social burdens on them as they have to help their mothers in the domestic chores. Where communal taps are available, long queues of girls and women with water containers on their heads or on wheel barrows are common sights. Having water near the household through RWH should result in the alleviation of these hardships on women. It would free their time and enable them to deal with other issues. The young girls might have a greater opportunity for education. Women need therefore to be an integral part of any decision regarding RWH project. Likewise, vulnerable groups such as orphans and HIV infected persons should also benefit from RWH. In areas with high prevalence of HIV/AIDS, orphans are more and more in charge of households and of the associated chores such as fetching water for the households. Beyond domestic use, RWH will uplift the standard of living of women who are involved in agriculture through increased crop yields and therefore increased household incomes.

d. Fourth principle: Water as an economic good

The economic value of RWH can be best understood by considering the opportunities lost through lack of RWH in areas where the potential exists. These can be expressed as the time wasted in collecting water, the lower yields from agriculture practices and greater food insecurity, etc. Economic evaluation is therefore a critical aspect of the implementation of RWH. Current economic evaluation methods of RWH range from a simple yield comparison to more sophisticated risk analysis methods such as stochastic dominance analysis (which are normally limited by data availability) (Senkondo et al, 2004). RWH raises the profile of water as an economic input in a culture where water is often taken as a gift from God or a social commodity which should be given for free. Without disregarding the fact that water is equally a social good essential to human dignity, a proper appreciation of its value need to be progressively gained in order to introduce an appropriate pricing strategy to recover the costs of supplying water.

4.2. Integrated RWH management

Considering the driving elements of water management (figure 3) and incorporating RWH, the environmental impacts are yet to be further explored and its management and regulatory institution are not in place. There is a high demand for water but the resource is limited. If RWH is to be considered as a water supply option, appropriate regulations need to be developed. The National Water Act, the Water Services Act and the National Resource Strategy (and any other legal or regulatory provision) should cater comprehensively for the use of RWH in the South African context. The recent policy on the subsidy of RWH for households is a good step in the right direction, but it has already led to questions on the institutional mandate of RWH. Both the Department of Water Affairs and Forestry and the National Department of Agriculture consider it their responsibility.

Beyond the environmental and institutional considerations of RWH there are the social and economical considerations. Many projects are not sustainable because the social and economic aspects are overlooked. When a new technology is introduced, the community needs time for adjustment and acceptance. Acceptance of new technology is greater when the community involved from the planning phase take ownership. Changes in the material culture take place at a faster pace than the non-material aspects of a community's culture. It is important to be aware of this difference when assessing the social acceptability of new technologies (Botha et al, 2005). The social impact of RWH on the community is yet to be investigated. Previous studies indicate a clear benefit of the use of RWH at household level. However at catchment level, the overall economic benefits and adverse effects of the implementation of RWH should be highlighted and balanced to help decide on the more beneficial water allocation between existing water use.

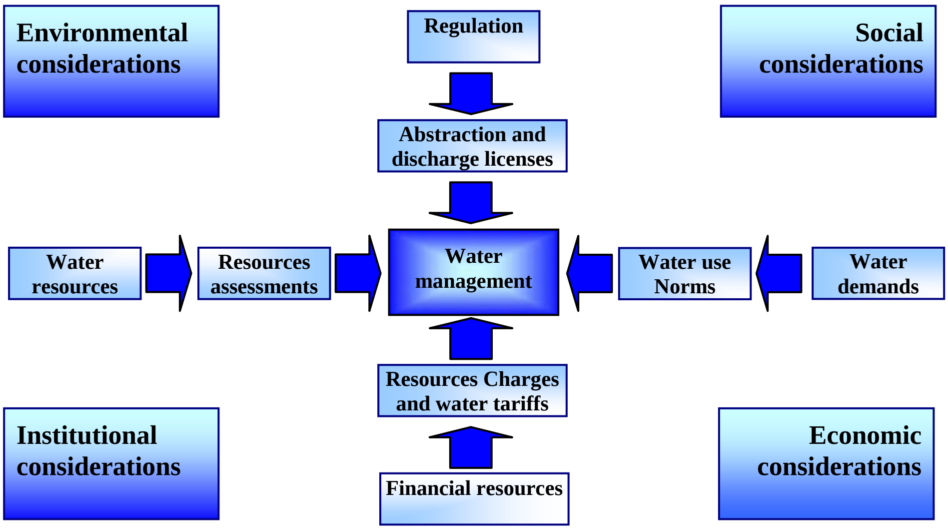

Figure 3. Driving forces of water management (Robinson, 2003)

Domestic RWH (DRWH) in urban areas is likely to have an impact on the water supply. In Germany, subsidies are given for construction of DRWH. DRWH reduces storm water runoff and recharges groundwater, delaying the construction of new Wastewater treatment plants. In Australia, studies indicate that in headworks systems with over-year storage capacity, the reduction in base demand provides a buffer against the effects of droughts and growth in water demand due to population growth (Coombes and Kuczera, 2003). Management of DRWH in urban centres should therefore be integrated in the management of the water supply. A recent study conducted by the Water Systems Research Group of the University of the Witwatersrand indicates that stormwater inflows and groundwater infiltration into sewers can reduce the originally designated capacity of the sewer collection system and negatively affect operation of the entire waterborne sanitation system including the wastewater treatment component (Stephenson and Barta, 2005). Therefore it will be prudent for domestic RWH in urban areas to be managed in coordination with the water supply provider. In the case of rural areas without service providers, there is a need to provide guidelines on the construction, operation and maintenance of DRWH.

There is debate about whether RWH is the same as irrigation practice (IPTRID, 2000). When compared to rainfed and irrigation, RWH holds an intermediate position (See figure 4). It provides for higher water productivity and crop yields than rainfed agriculture with increased salinity hazard. However, with small-scale farmers who usually use organic fertiliser and small quantities of inorganic fertilisers, salinity hazards can be considerably reduced with RWH systems.

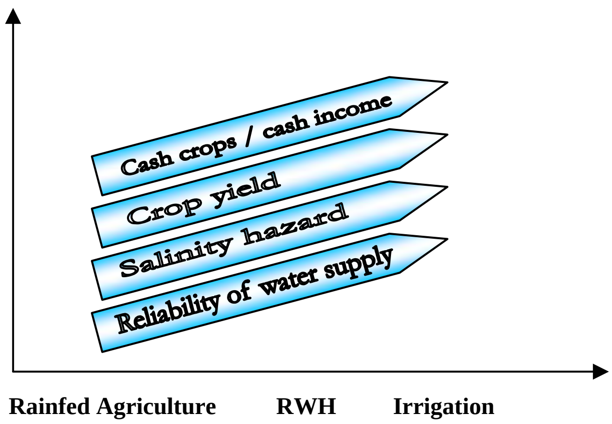

Figure 4. RWH compared to other types of agriculture Prinz 1996

An important component of South African agricultural policy is to increase incomes of the poorest groups in society through opportunities for small/medium-scale farmers. The National Agricultural Policy gives particular attention to small-scale agriculture with three strategic aims: (a) making the sector more efficient and internationally competitive, (b) supporting production and stimulating an increase in the number of new small-scale and medium-scale farmers and (c) conserving agricultural natural resources (IPTRID, 2000). Most small-scale irrigation abstractions are likely to be classified under schedule 1 use for which no registration or licensing is required.

In old irrigation schemes that have to accommodate many small farmers, the solution could be a conjunctive use of RWH and irrigation. Increase of water productivity has been observed when RWH is combined with drip irrigation and fertilisers. To support small scale farmers, an interdepartmental committee comprising the Department of Water Affaires and Forestry, the National Department of Agriculture and the Provincial Department of Agriculture has been established. RWH should benefit from this existing cooperation, with one beneficial implication being the integration of rainfed and irrigation agriculture. Beyond the use of small-scale RWH systems by small holder farmers, upscaling will require an evaluation of RWH impact on the hydrologic cycle. To achieve this from an IWRM perspective, a decision support system is required.

5. Developing a GIS-based decision support system

The decision support system (DSS) should give an indication, for any given area in South Africa, of the potential and suitability of RWH, its impact from upscaling on the country water resources, and become the driver for policy formulation.

A decision support system should assist the planner by:

- Defining the problem
- Generating scenarios
- Evaluating alternatives
- Indicating the best alternative for implementation.

Building of the DSS will be done as follows:

- Develop a conceptual model for the DSS
- Calibrate model
- Extend models application on country-wide basis

Geographic information systems (GIS) will be used to facilitate and improve the assembling, display, and visualization of model inputs, parameters and as well as the model outputs. Consequently simulation models and GIS will be coupled, with GIS serving as a pre-processor of data and maps for use by the physical model. The following steps are proposed in developing the DSS.

5.1 First step: Defining the users needs

The first step will be to identify potential users of the DSS and the users' requirements:

- Make a list of potential users;
- Provide a feedback mechanism through a stakeholder workshop;
- Document users' requirements.

5.2 Second step: Define objectives

The second step streamlines the DSS to address user's requirements. The conceptual model of the DSS should have two parts, one for the Domestic RWH and another for the in-field and ex-field RWH.

5.3 Third step: Identification of potential RWH areas

The third step will be to identify potential areas where RWH can be implemented using remote sensing and GIS.

a. Domestic RWH

Domestic RWH can be practised everywhere.

b. In and ex-field RWH

Most the needed maps already exist and only need to be adapted to suit the study.

- Make a map of rainfall intensity and distribution, eliminate areas with Mean annual precipitation (MAP) <100mm and areas with (MAP) >1000mm;
- Make a soil survey (Soil type and depth) to identify areas suitable for implementation of RWH. Good soils induce enough runoff and are capable of storing a certain amount of water in their profile;
- Make a map of the land cover. There is a direct relation between land cover and runoff induced;
- Make a digital elevation model (DEM) of the areas with suitable soils. Landforms, slope gradient and relief intensity are key factors when deciding on the type of RWH;
- Make a map of community water supply and sanitation (CWSS).

5.4 Fourth step: Identification of an area to model

After super-imposing all the maps of relevant parameters (Rainfall, soil, land cover, topography and CWSS) potential areas suitable for RWH will be identified. Ground validation will be done to confirm the findings. Since modelling needs data for validation, an area where RWH has already being implemented will be selected to study the effect of upscaling RWH on catchment hydrology. The areas should at the most be a quaternary catchment.

- Select site with gauging station where RWH is being practised;
- Analyse flows prior to RWH implementation and model the catchment dynamics;
- Simulate the introduction of RWH and calibrate model on existing data;
- Validate model and run different scenarios.

The above will first be done on a daily time step in order to have a good grasp of the physical processes. Thereafter a larger time step of a month could be used, while ensuring that the parameters used in the monthly model remain meaningful and representative of the processes at such large time scale and at a greater geographical scale. The next step would be to populate the DSS with information for the entire of South Africa and to gradually test and verify the DSS for parameters that will guide the progressive implementation of RWH at a large scale. When the DSS is built, an important activity will be training of the users, support and maintenance of the system.

6. Conclusion

RWH is an old practice that is considered a new viable water source for water-scarce South Africa. It holds the potential of providing historically disadvantage groups with access to water, thereby ensuring food security at household level. Studies within the country strongly indicate the socio-economic benefit of the use of RWH at plot scale. However, for a proper integration into the national water resources management strategy, there is a need to go beyond the plot scale to a larger scale that assesses its impact on the hydrological cycle.

The paper presents the preliminary findings of a three years study that is at its inception phase. On-going survey indicates that RWH is practised in South Africa and it has a wide acceptance by the populace. The current legislations do not give a clear legal framework for the adoption of RWH at large scale. Although it is mentioned in the national water resources strategy, many sections of the National Water Act can be used for and against the use of RWH. To give basis for the formulation of relevant policies, there is a need to evaluate the impacts of large-scale RWH on the hydrological cycle. To integrate RWH, a clear definition and understanding of the technique is needed. Being in between rainfed and irrigation agriculture, in field and ex-field RWH should be managed by the institutions that are currently managing the irrigation sector. This will eliminate fragmentation. It is also suggested that Domestic RWH in urban areas should be managed in cooperation with the water supply providers. The paper also outlines the methodology for the development of a DSS for use of a RWH in South Africa.

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